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Population vs. Resources

What Kind of a World Tomorrow?

The 123d annual meeting of the American Association for the Advancement of Science was held in New York City December 26-30. A total of 5,327 registrants, and some 10,000 science-minded people listened to 1,082 papers which ran the entire gamut of human knowledge from atoms to zoology.

A session which attracted unusual interest was a symposium on Resource Development and Population Growth sponsored jointly by the sections of industrial science and of social and economic sciences. Mr. Monroe E. Spaght, Vice President of Shell Oil Company, presided. Dr. Harrison Brown, Professor of Geochemistry at California Institute of Technology, considered the productive potential of the earth in terms of energy and available raw materials. Dr. Fairfield Osborn, President of The Conservation Foundation, discussed the reproductive potential of the human species.

A lively discussion from the floor was preceded by statements from three symposium discussants: Robert C. Cook, Director of the Population Reference Bureau; Samuel H. Ordway, Executive Vice President of The Conservation Foundation; and John D. Durand, Assistant Director in charge of Population, Bureau of Social Affairs, United Nations.

At a luncheon session following the symposium, Dr. Earle L. Rauber, Vice President and Director of Research of the Federal Reserve Bank of Atlanta, challenged the assumption widely held in some quarters that this country's rapidly growing population automatically means an expanding economy.

In his address as retiring President of the AAAS, Dr. George W. Beadle, Professor of Genetics at the California Institute of Technology and one of the world's leading geneticists, warned that rapid population growth is creating serious problems.

So that *Bulletin* readers may be more fully informed about these important statements by four eminent scientists—an economist-banker, a geneticist, a conservationist, and a geochemist—this issue reproduces the Rauber speech in its entirety and an abstract of the Brown speech. It also quotes liberally from the speeches of Beadle and Osborn.

—R. C.

Population and Economic Growth

by DR. EARLE L. RAUBER

Dr. Rauber is Vice President and Director of Research of the Federal Reserve Bank of Atlanta. He is retiring Vice President of the Section of Industrial Science of the American Association for the Advancement of Science.

It was with great interest that I read the program that Dr. Bonnell had planned for Section P at this 1956 meeting of the American Association for the Advancement of Science. In making population the focus of attention, Dr. Bonnell reveals himself as one endowed with unusual prescience—a quality that he shares with the famous historian, Arnold Toynbee, who recently said that the problem of population was the gravest that will be confronting us in the not-too-distant future and that it may well be the one on which our civilization founders in the end.

Speaking only for myself, I sometimes feel that we economists pay far too little attention to this question, although you would think that we of all people would be most concerned with it, as, indeed, we once were. In these latter years we seem to have become so bemused with the ups and downs of our statistical aggregates and with the shifting patterns within them that we have almost lost sight of the fact that the economic drama is acted out by and for human beings —creatures who are driven by an imperious desire to reproduce themselves and are only partially restrained by social factors from doing so to the biological limit of their capacity. We sometimes forget, too, that population is not just instrumental in the economic process, but that its welfare is the final object of that process—the criterion in terms of which the success of the economic process must in the end be judged. Our technical ability to produce goods, therefore, and our biological capacity to reproduce ourselves are the two ultimate variables upon which the material wellbeing of mankind depends.

Looking back over history, one's attention is drawn to certain years that seem to have been heavier with destiny than others. Such a year was 1776. Three events of transcendent importance for the future occurred in that year—the appearance of Watt's steam engine, the publication of Adam Smith's "Inquiry into the Causes of the Wealth of Nations," and the signing of the American Declaration of Independence. These were not three unrelated and disparate events but were, rather, three manifestations of one profound historical event—the birth of freedom.

The steam engine, which harnessed to man's use the energy

locked up in the world's coal beds, freed man forever from dependence upon his own muscles or those of work animals and paved the way for all subsequent conquests of power—oil and gas, electricity and nuclear energy. Without the steam engine these latter triumphs would have been unthinkable.

On another side, the steam engine freed industry in the matter of its location. Heretofore industry was compelled to cling to the banks of rivers either to secure the benefits of water power in production or because of the advantages that such sites provided for transportation. The steam engine, however, allowed industry to settle down in any place to which the ribbon of steel rails could be pushed. The steam engine, therefore, was the first long step toward technological freedom. It was itself the fruit of the union of science with industry, a union that has produced the amazing progeny with which we are now surrounded and which we take as a matter of course.

ADAM SMITH'S ECONOMIC THEORY

The publication of Adam Smith's classic work had a somewhat similar liberating influence in the realm of thought. Smith saw man as a creature endowed with an instinct to better his lot. He was also endowed with an instinct to truck or barter with his fellows. Since human talents and capacities differ, it was therefore natural for one person to do what he could do best and then to trade his product for that of others. In that division of labor Smith found the key to all material progress. Out of the striving of each man for his own betterment came the betterment of all as though led "by an invisible hand." The benefits of division of labor, however, could only be realized in an atmosphere of freedom—in a state where there was the minimum of interference with economic activity by government.

It was the signing of our Declaration of Independence and the kind of political structure later embodied in our Constitution that provided the first testing of Adam Smith's thesis. In this country alone were the economic energies of men free to employ the fruits of science in the exploitation of tremendous natural resources for the aggrandizing of their material welfare. In this country more than in any other the private businessman —the enterpriser, the entrepreneur —became the center of the economic process with results that we all can see. In this country we have achieved the highest standard of living ever to have been achieved in all history. Adam Smith and our revolutionary forefathers have been fully justified in the sequel. So successful has this free enterprise economy of ours been that the idea of progress has become with us almost a religious concept. To doubt the inevitability of endless progress in the future is a kind of heresy that no right-thinking man would be guilty of committing. As

one of our large corporations reiterates in its commercials on television, "Progress is our most important product."

THOMAS MALTHUS' POPULATION THEORY

Every rose, however, must have a thorn, and every paradise must have a snake hiding somewhere in the bushes. So too with the paradise of naturalistic optimism envisaged in Adam Smith's "Inquiry Into the Causes of the Wealth of Nations." In 1798 in England, a young clergyman published anonymously a work entitled "Essay on the Principle of Population as it Affects the Future Improvement of Society." This clergyman had been studying the growth of population in England and came to the conclusion that it tended to double every twenty-five years. The food supply, however, increased only at a much more pedestrian rate. If this continued, it was obvious that at some point there would not be enough food to sustain the population and that the excess would die of hunger or pestilence, or would kill themselves off in war. The only alternative would be the postponement of marriage and the exercise of a much greater degree of continence within marriage than had hitherto been practiced. Thus, it seemed that humanity's reproductive ability would in the end triumph over its productive ability. It was this new note that Thomas Malthus (for he was the clergyman author) injected into economic science that has given it the name of the "dismal science." Someone has suggested that his essay should have been entitled "An Inquiry into the Causes of the Poverty of Nations."

The dire predictions of the Malthusians, however, did not materialize in the nineteenth and twentieth centuries. Population grew rapidly, of course, but the standard of living in all civilized countries nevertheless improved, too. Science, armed with steam and steel, was conquering the resources of vast new areas of the earth's surface and everyone was living better than before despite rapidly increasing numbers. All the whispered fears of overpopulation were drowned in the hubbub of industrial progress. There even arose some talk of the opposite disaster —race suicide.

THE BABY BOOM THREATENS U.S. LIVING STANDARDS

The baby boom that followed World War II and that upset the forecasts of the population experts —a boom that may repeat itself when the wartime crop of babies comes to marriageable age—is forcing us once more to consider the relation between population growth and our ability to expand production enough if we are to avoid a decline in the standard of living of which we are all so proud. It is to this point that I now wish to address myself. I am not claiming statistical impeccability for my calculations for I am merely trying to paint in rather broad strokes some relations and tendencies that bear careful watching.

I would direct your attention, first of all, to the most general statistical aggregate that we have —the so-called Gross National Product. This purports to represent the totality of goods and services produced in the country, expressed in terms of current prices. It is thus a measure of the output of our economy in terms of dollars. As it grows, our pride of achievement grows. It is very easy to fall into the fallacy of thinking that the greater the Gross National Product, the more prosperous are the people of our country. The increase in the Gross National Product from roughly 214 billion dollars a year in 1945, when the second World War ended, to the 414 billion dollars a year rate in the third quarter of this year seems really something to boast about! That represents an increase of almost a hundred percent in just a little over ten years.

We must remember, however, that this aggregate is stated in terms of current prices and we know only too well that prices vary from time to time. To get at the meaning of the Gross National Product figures in terms of goods and services, therefore, they have to be deflated to eliminate the effect of changing prices. We must remember, too, that the population is growing and that the Gross National Product must be shared among more and more people. Making these two adjustments—dividing by the population figure in order to reduce the aggregate to a per capita basis, and then deflating that per capita figure by the index of consumers prices (1947-49 = 100) we arrive at a real per capita Gross National Product figure that gives some indication of the increase in average economic well-being.

In 1945, this real per capita Gross National Product figure stood at $1,990 a year. In the third quarter of this year it was running at the rate of $2,099 a year. In other words, after a little over ten years of expansion, our economy was producing only $109 more of real goods and services per capita than it was in 1945. This was an improvement, certainly, but not as spectacular a gain as we might have expected.

Another statistical aggregate with which economists are concerned is the so-called "Personal Disposable Income." This is total personal income less the amounts that are paid to governmental bodies in the form of taxes. In other words, Personal Disposable Income is what the American people have left to live on or to save after the various tax collectors finish with them. In 1945 this figure amounted to a little over 150 billion dollars. In the third quarter of this year it was running at an annual rate of about 288 billion dollars in terms of current prices, an increase of 138 billion dollars.

If, however, we make the same sort of adjustments here as we did

in the case of the Gross National Product figures, we will get a figure for real per capita income, i.e., a figure that represents in terms of actual goods and services what the average person has to spend or save. In 1945, real personal disposable income per capita amounted to $1,401. In the third quarter of 1956 it was running at the rate of $1,462 a year. In other words, after ten years of economic expansion, the average person was getting only $62 a year more to spend or save.

THE PRICE OF BIGNESS

This seems to be a miniscule result when set side by side with the prodigious investment we have been making in new plant and equipment—that is, in our capacity to produce goods and services. In 1950, for example, we spent 21 billion dollars for new plant and equipment and in 1955 approximately 29 billion. Expenditures for this purpose increased at an average rate of 1.6 billion dollars a year during that five year period. In 1956, however, we are spending over 36 billion dollars—over 7 billion more than we did in 1955, or about four and a half times the average annual rate of increase between 1950 and 1955.

Why is it that this enormous expenditure for new plant and equipment is not yielding anything like a commensurate improvement in the quantity of goods and services at the disposal of the average person?

One reason is that our economy is now so large that large expenditures are needed merely to replace the plant and equipment that is falling out of service for one reason or another. It has been estimated that nearly 17 billion dollars of the 36 billion being spent in 1956 goes for replacement alone.

Another reason is that it takes over 5,000 dollars in new plant and equipment (to say nothing of land, working capital, accounts receivable, or other forms of capital) to equip a worker for his work. The working force in 1956 is roughly a million larger than it was in 1955. About five and a third billion dollars in new plant and equipment would therefore be absorbed by this addition to the labor force. This leaves something less than 14 billion dollars for actual expansion of our productive facilities, approximately 240 dollars per worker. This represents an increase of only about 4 percent in the capital equipment available per worker.

The gain in wellbeing that might be expected to accrue from this increase of 4 percent in the plant and equipment per worker is further offset to some extent by the fact that each man at work is having to support more and more who are not working. Look at the growth of different age groups in the population: Between April 1950 and July 1955 the population of the country increased 9.3 percent. Children under 5 years increased 13.2 percent, and those between 5 and 13 years increased 26.8 percent. The 14 to 17 year age group increased

9.5 percent, but the 18 to 65 year group—the productive ages—increased only 4 percent—less than half the average for all ages. Persons 65 years of age and over increased 15.9 percent. This disproportionate growth of the non-productive age groups in the population is another serious drain on the productive capacity of the country.

Taken together, then, the fantastic investment needed just for replacement, to equip newcomers to the labor force with the prevailing complement of tools and machinery, and to support the growing number of non-productive persons, represents an equally tremendous demand for savings that must be made by the economy. In "Alice in Wonderland" the Red Queen tells Alice that she must come from a very slow country. "Now here," said the Red Queen, "you have to run as hard as you can just to stay in one place. To get anywhere else, you have to run twice that fast."

OUR "MORE PSYCHOSIS"

A good deal of the current boom in investment that is alarming some people because of its inflationary dangers, is in the nature of running we must do just to stay in the same place. To improve our level of living we shall have to run a great deal faster.

Society is free to enjoy the fruits of increased productive capacity in one or another or some combination of three ways. It can take the benefit in the form of more goods, or more leisure, or more children. We Americans, however, want all of these things simultaneously—we want more automobiles; more houses; more television sets and washing machines; more hospitals and schools; more roads; more factories; more skyscrapers; more of everything, just when we also want shorter hours, longer vacations, earlier retirement—in short, when we want to work less. And now, in addition to everything else, we also want big families.

To a considerable extent we have been fortunate in this country—we have been able to do all of these things. It is doubtful, however, that we can keep on doing so for long. Sooner or later, if it persists at its present rate, the increase in population will encroach on all other elements in our standard of living which will then of necessity begin to decline. The cloud that Malthus saw on the horizon in 1798 may take on sinister proportions before this century is out. Toynbee may be right after all, and our civilization may perish if we do not bring the population problem under control.

The one sure way out of the difficulty would be the voluntary and sufficiently drastic limitation of the birth rate for the sake of the future. Few indeed, however, are likely to be that much interested in the future. As long as the present is as rosy as it is now there is little likelihood that this voluntary check will prove very effective. Something more is required.

A PLEA FOR RATIONAL THINKING AND ACTION

In every civilization there are a few key figures upon whose shoulders rest the burden of carrying that civilization forward. It is their decisions that provide both direction and momentum to the whole cultural complex within which they work. In our particular civilization these fate-figures are, speaking generically, the scientist, the entrepreneur, and the banker. As Toynbee correctly sees, the greatest challenge that these figures will face in the future is likely to come from the growth of population at a rate greater than the rate of growth in the economy that must sustain it. Our future welfare depends on the success with which our key figures meet the challenge. What can be done?

Consider, first, the scientist. Science is generally looked upon as the panacea for all ills. Science will find a way out of this population dilemma, too, it is thought, and we can still enjoy more and more babies and more and more of everything else. I am not quite so sanguine as all this, but I do believe that science has a contribution to make. Scientific research is constantly finding ways of achieving given results or even greater results by the use of smaller quantities of physical resources. The marvelous developments in the field of miniaturization are cases in point. This is all to the good, and, it seems to me, scientists have a moral and social responsibility to deliberately bend more of their efforts toward capital-saving and resource-conserving processes. Ideally, of course, the scientific spirit, like the Holy Spirit, "bloweth whither it listeth," and mankind is supposed to profit from this pursuit of what Thorstein Veblen once called "idle curiosity" only in its accidental results. Our problems today, however, are too pressing to be allowed to remain at the mercy of accident. The urge to pure research must discipline itself in the direction of those tasks that promise most to mankind in the way of conserving the scarce resources with which nature and our own ingenuity and past sacrifices have endowed us.

The second key figure in our society is the businessman, the entrepreneur. It is he who organizes production. Under present circumstances the entrepreneurial function is most often exercized by the management of great corporations. It is to be presumed, of course, that entrepreneurs, great and small, operate in response to the profit motive. Even so they may still have the option of using their talents in directions that conserve capital and other resources or of expending them on wasteful and extravagant ventures. For the sake of the future of our free economy, entrepreneurs should throw the weight of their influence against all waste and extravagance and in favor of the most economical use of the resources over which they have disposal.

I think, too, that my friends the bankers have some part to play in this task of forestalling the worst results of this tendency for population to outrun the means of sustaining it. The banker's function is essentially critical. It is the banker who decides how the not unlimited supply of credit is allocated as among the various demands for it. He is therefore in a position to exert a definite influence over the direction in which credit flows. It is part of his social responsibility to see that credit is used to increase the ability of the economy to sustain the life of the population, and not merely to facilitate the squandering of our resources in trivial and often unnecessary consumption by a thoughtless public.

SAVING IS STILL A VIRTUE

The rest of us, too, may also do something in this common task. We can relearn, if we try, the virtues of frugality and saving. If the army of babies that even now looms over the horizon is to be fed, and clothed, and housed, and educated, and set to work on at least an equal technical level with the present population, both industry and government are going to need all the savings they can lay their hands on. If we fail, as individuals and as corporations, to save the needed amounts voluntarily, the clamorous demands of the public for the things they need will bring about a kind of forced saving by the road of inflation. This, however, is no remedy at all. It is an illusion. We can not eat, wear, or live in depreciating dollars. The scarcity that is already afflicting us is not a scarcity of money, but rather a scarcity of resources. There are not even now enough physical resources for us to do everything we want to do at one time. Unless science can pull off more miracles than now seem probable, this scarcity of physical resources vis-a-vis the demand for them by a rapidly increasing population will be much greater in the future than it is now.

The vision of Adam Smith has indeed had its fulfillment in the inordinately productive industrial superstructure that businessmen have erected on foundations laid by the scientists. The brightness of that vision, however, is even now somewhat dimmed by the shadow of Thomas R. Malthus. There is a danger that the coming hosts of babies may engulf us in the end unless we bestir ourselves in time. We are apparently caught, or will soon be caught, in a race between productivity and reproductivity. The improvement or deterioration in our standard of living in the years to come is going to depend upon the outcome of that race.

A Geneticist's View

Dr. George W. Beadle's address as retiring President of the American Association for the Advancement of Science was entitled "Uniqueness of Man."* He reviewed the evolution of man as a genetic system, culminating in a unique cultural inheritance. "The reactions of individuals and groups of the human species to various environmental situations are obviously a result of complex interactions of the two types of inheritance."

. . . Although cultural inheritance may have had its first beginnings a half-million years or more ago, it has expressed itself most spectacularly in the last half-dozen millenia. Ancient and modern civilizations with their technologies, arts, music, literatures, sciences, and religions are its products.

Modern technology and science have evolved within a period of a few thousand years. They in turn have made possible the industrialization that has in the past few centuries developed to such a high degree in a few nations of the world.

The recent evolution of cultures, especially in technologic and industrial directions, has created for man an entirely new set of opportunities together with a closely interrelated group of problems. As agriculture provided more food, populations grew. Further technology was catalyzed. Tools evolved, first of stone and wood, then of bronze and copper, and finally of iron and steel. Manpower was supplemented by domestic animals and by machines driven with the energy of burning wood, coal and oil. At the same time, the art and science of medicine was responsible for spectacular increases in life-expectancies. This helped populations to grow still more rapidly.

All this is an old and well-known story. It is also well known that with urbanization, industrialization, and improved health practices, birth rates tend to fall off, but only after a lag of several generations. This lag is especially marked in those cultures in which for one reason or another education and accompanying industrialization develop very slowly. This is because in general it is easier to introduce drugs and physicians to such cultures than it is to raise markedly their levels of education and technology. Thus, as the demographic transition is made in one culture after another, populations tend to increase sharply and then become stable.

For a world with half its nations industrialized and half not, and with its natural resources very unequally distributed, the present population of more than 2500 million is far too large. More than half the people of the world are

*The full text of Dr. Beadle's address has been published in SCIENCE for January 4, 1957.

underfed, are poorly housed, receive little modern medical care, and are inadequately educated. It is small wonder that populations who see so little hope in other directions can be so easily stirred to rebellion and led to war by power-hungry demagogs, charlatans and other persuasive men of little wisdom.

Overcrowding of hungry people who see little hope for a brighter future is by no means the only cause of war, but it is surely an important one. And without the slightest doubt, war is the most serious of civilization's immediate problems.

Human warfare is as old as man himself. As a part of man's culture, it has evolved from primitive forms of man-to-man combat through the many intermediate stages to its present highly perfected state. During this course, wars have become progressively larger and more devastating.

With the development of nuclear weapons, we see a significant discontinuity in this evolutionary sequence. Up to this point wars were largely self-regulating in one way or another, usually through the achievement of victory, hollow though it might have been, by one party. With wars of nuclear weapons, it is entirely conceivable that there will no longer be victors. Participants and onlookers, too, may perish from blast, radiation, and starvation.

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Although the task of preventing a major war in the immediate future is assigned to the statesmen of the world, with special responsibility in the hands of those of the more powerful nations, there are many ways in which science can and must contribute toward basic and long-term solutions.

It is difficult for men with empty stomachs to know right from wrong. If the presently available scientific knowledge of agriculture were applied on a world-wide basis, hunger could become unnecessary. But the economic, political, and social problems inherent in doing so are made enormously more difficult by the fact that they must be solved in terms of a world divided into many nations. Solutions are possible, and every possible effort should be devoted to attempts now being made to arrive at them.

In the time required to increase food production sufficiently to feed more than 2500 million people adequately, there will, unfortunately, be many more than that to feed. With the present excess of births over deaths, the world's population is annually increasing by 30 to 40 million. Food production must therefore more than catch up with present needs. This will require that efforts be stepped up by even larger factors. More land must be brought under cultivation and yields must be increased. This means more fertilizer, more water for irrigation—perhaps through recovery from sea water—and more plant and animal breeding. The food of the oceans will have to be

harvested in increasing amounts, and the practicability of entirely new methods of agriculture, such as those of algal farms, will have to be explored.

All this will require more technology and a great extension and evolution of industry. Consumption of raw materials and energy will rise markedly. The general level of education will have to be raised on a world-wide basis. Better use of manpower resources, especially at the intellectual level, will be increasingly necessary.

If the peoples of the world can somehow be induced to work together, there is no apparent reason why all of this cannot be done.

While it is being done, what will be the trend of population growth? With the spread of technology and education, will birth rates in fact fall off until populations reach approximate equilibrium in size? It is a widespread belief that they will. The decreased birth rates that accompany education are attributed to an increased desire to limit family size plus greater knowledge of birth control techniques. If so, education and the discovery and development of improved methods of birth control may in time largely solve the quantitative problem of population growth.

However, the hope that prosperity and education will continue automatically to lead to population stabilization through voluntary birth control has been considerably dimmed by the marked postwar increases in birth rates in the United States and other industrialized nations. Indeed this phenomenon raises the question of whether Malthus was not fundamentally right, in spite of his many detractors of recent times.

Whether or not the present high birth rates in industrialized nations are temporary and will in the long run be smoothed out at a lower level, the whole question of the adequacy of voluntary family limitation in regulating the growth of populations will have to be faced sooner or later. This is because the problem of control may not be a wholly quantitative one. Because it will inevitably be uneven in its application, voluntary and individual family control is bound to lead to changes in population composition. Differences in net reproductive rates may depend on such factors as genetic background, cultural history, and economic status. Whatever their cause, they may well produce population changes of the greatest significance to man's future. For example, it has many times been pointed out that under a system of voluntary birth control the less fit intellectually may be lacking in social responsibility and might therefore have a higher than average net reproductive rate. If differences in intelligence of this kind have an important genetic component, there is a theoretical possibility that progressive intellectual disintegration could become an important factor in shaping the

nature of future populations.

Alternatives to population control through voluntary decisions on the part of individuals—society-imposed family quota schemes, to mention one conceivable possibility —raise religious, moral and ethical questions of such magnitude that no responsible society has ever given them serious consideration except under the most unusual and special circumstances. It could well be that societies may eventually be forced to face this unpleasant problem more realistically than they so far have.

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Man's evolutionary future, biologically and culturally, is unlimited. But far more important, it lies within his own power to determine its direction. This is a challenge and an opportunity never before presented to any species on earth.

It has been clear for a long time that man is potentially capable of cultural self-direction — that he could, to a much greater extent than he now does, consciously select his cultural objectives. What is not so obvious is that it has now become possible to exercise a comparable degree of control over his purely biological evolution.

Through the understanding of heredity that man has gained within the past half-century, he has acquired the power to direct the evolutionary futures of the animals he domesticates and the plants he cultivates. At the same time and in the same way, he has won the knowledge that makes it possible deliberately to determine the course of his own biological evolution. He is in a position to transcend the limitations of the natural selection that have for so long set his course.

But knowledge alone is not sufficient. To carry the human species on to a future of biological and cultural freedom, knowledge must be accompanied by collective wisdom and courage of an order not yet demonstrated by any society of men. And beyond knowledge, wisdom and courage, faith, too, will be essential. Man must have faith in himself. He must have faith in the rightness and goodness of his goals. And many would add that he must continue to have spiritual faith.

Faith, belief, and the urge to go on and on have themselves come out of man's past as a part of the evolutionary pattern that has fashioned him into the unique being he is. In his uniqueness, he is capable of attaining heights far greater than his most magnificent cultural achievements of the past.

A Conservationist's View

Dr. Fairfield Osborn is President of the Conservation Foundation and of the New York Zoological Society. He is author of "Our Plundered Planet" and "The Limits of the Earth." He discussed "Our Reproductive Potential."

The "Reproductive Potential" of the human race is at last being recognized as perhaps the most basic and certainly one of the most ominous problems facing the world today. It is, of course, overshadowed by the more immediate crises between freedom-loving peoples and the authoritarian forces of Communism. It is also secondary to the question "Shall there be war or peace?" Yet in the search for peace there is mounting evidence that the pressures resulting from rapidly growing populations are without question a major cause for the great majority of conflicts between nations. For my own part, I will go a step further and express my belief that the hope for world peace is remote, or even unattainable, until the pressures resulting from population growth are relieved.

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In summary, then, the three natural controls upon population increase [starvation, disease and war] have either been largely removed or are of small influence. The consequence is that there has occurred a violent and completely unprecedented increase in populations throughout the world during the last century or more. Further, the *rate* of increase continues to accelerate. These facts are well known, but in order to highlight them I should like to recall to you that during the last one hundred years the world's population increased from 1 billion 200 million to 2 billion 400 million, or an average of 12 million per year. In comparison, some 300 million people have been added to the earth's numbers within only the last *10* years, or an average of 30 million a year. One does not need a computing machine to figure out that this means more than 80 thousand each day. Presently, the daily increase is estimated to be nearer 100 thousand each day. These figures represent man's "Reproductive Potential" as of this time.

THE VITAL BALANCE

It is a disconcerting irony that this extraordinary increase in human numbers has come about principally through the beneficent influence of medical science and public health measures, resulting in greatly reduced death rates. The question therefore is: How long can we accept this boon without facing up to the need for equivalently reduced birth rates?

Strangely enough, it is only within recent years that wide attention is being focussed upon the far-reaching implications of this essential human problem. In historical times, it is true, various societies of people were acutely aware of the question of over-population and not infrequently strict controls

were enforced. In modern times the problem has been obscured for a various number of reasons including cultural, religious and national attitudes. Further, during the last century or more, population pressures, especially in the western world, have been relieved by new methods of transportation which aided migrations, by industrial development in many countries that absorbed ever larger labor forces and, finally, by the fact that the settlement and development of the western hemisphere provided an outlet to great numbers of people in overcrowded countries. These reliefs can no longer be counted upon to any important degree.

In view of the fact that scant attention has been given to this worldwide question until recently, it is the more notable that today there is a great awakening to the seriousness of the situation. Within the last few years several governments, to which I shall refer shortly, are undertaking specific action toward population control. Further, the United Nations has given at least an initial nod to the existence of the problem by sponsoring successively two world conferences, the first, the United Nations Scientific Conference on Conservation and Utilization of Resources, held at Lake Success in August of 1949, and more recently, the World Population Conference held in Rome in August of 1954. Quite apart from governmental interest there have appeared in recent years a growing number of books, articles and other publications on the subject and, as well, many conferences by various groups have taken place including discussions such as this now being held under the auspices of the American Association for the Advancement of Science. Yes, action and interest are both "sharpening"—and, I might add, it is high time.

[After reviewing the controversy between the "Pessimists," who see danger in over-rapid population growth and the "Optimists" who believe that the cornucopia of technology can provide for any number of billions of people, Dr. Osborn discussed developments in India, China, Japan and Egypt.]

. . . These examples in very recent times indicate the degree to which population pressures contribute to international tensions and even war. Situations such as these and many similar previous ones present a fine opportunity for the present-day historian to go much deeper in analyzing *causes* of the great conflicts in human history rather than dealing principally with recitals of *effects*. Up to this time too many historians have "missed the boat" in this respect. Aldous Huxley, in one of his recent essays entitled, TOMORROW AND TOMORROW AND TOMORROW, with understandable irony, writes, "In the index at the end of the sixth volume of Dr. Toynbee's A STUDY OF HISTORY, Popilius Laenas gets five mentions and Porphyry of Batamaea, two; but the word you would expect to find

between these names, Population, is conspicuous by its absence. In his second volume, Dr. Toynbee has written at length on 'the stimulus of pressures'—but without ever mentioning the most important pressure of them all, the pressure of population on available resources." It is heartening to realize that Arnold Toynbee, learned man and eminent historian, has finally come to a full realization of the importance of what we are discussing here today. In a broadcast last October, he stated, "The abolition of war, working in combination with the lowering of the death rate through our recent vast improvements in public hygiene, is going to raise, in an acute form, the problem of population. . . . Is mankind going to rid itself of two of its three traditional scourges—war and pestilence—only to be done to death by the third scourge, famine? Surely we are not going to be so stupid as that. Yet, when we have done all that science can do to increase the world's food supply, the only way left open to us for coping with the continuing increase in population through the reduction of the death-rate will be to offset this increase by a corresponding reduction in the birth-rates."

A WORLD-WIDE PROBLEM

There is a persistent tendency in our part of the world, the "Western World," to think and talk of the population problem as if it were peculiar to the Far East and, more vaguely, to "underdeveloped" countries. There are grave errors in this attitude. One of them is that a number of countries in Europe are themselves faced with the problem, some to an aggravated degree. Another is that, if the Western World is going to assume any leadership in dealing with the problem as a whole, it will need, by its example, to openly and avowedly recognize its own involvement. Otherwise our motives — and this applies perhaps especially to us in the United States—will be subject to grave suspicion throughout the rest of the world. What then of a candid examination of the situation in our own country?

Assuming that present rates of increase continue we shall have 60 million more people in our country within 20 years. Our rate of increase, by the way, is greater than that of India, and higher than even the world average. Our prevailing attitude is one of taking it for granted that such an increase is desirable. There is much talk of "more sales," "expanding markets," and even higher "standards of living". Fortunately our country has the benefit of enlightened leadership within the business and industrial world, an enlightenment that is steadily spreading, as evidenced, for instance, by the increasing support given by large corporations to "general welfare" purposes such as education. Of late, too, business leaders and economists are beginning to analyze this "rising standard of living" theory and are questioning its validity.

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I believe that such benefits as may come to our country through a much larger population will be outweighed by the disadvantages and problems that will arise. Whether or not we shall be able to maintain our present standard of living is certainly open to question. There are related questions, such as: Will world conditions enable us to draw from other countries the continuing supplies of raw materials that today are essential to our economy? At the present time, with less than 10 per-cent of the free world's population and 8 per-cent of its land area, the United States has come to consume almost half the free world volume of materials. No one can answer this question with assurance. One thing is sure—the greater the demand due to the needs of an ever-larger population the more this question will press upon us and the less likely that the answer will be affirmative.

On the domestic front we shall not actually run short of food though, in all probability, surpluses will be a thing of the past, even within the next few years. The great technical advances in forest management will presumably provide enough fibers, or substitutes will be developed. As regards these two basic resources we need not have, perhaps, too great concern. The real pinch will come in water-supply, already an acute problem for some 50 million people in various regions of our country. If the question were asked "Can we solve this problem of insuring adequate amounts of these basic natural resources?" I think the answer would have to be a qualified "yes" because the natural richness of our country, the technical skills to be drawn upon and the adaptability of our people, are of such a high order. The qualification, however, is a major one, namely, that the larger our population the more difficult the solution, the greater the threat to our economy and, finally, the increased chance of actual distress to large segments of the American people in the event that adequate solutions cannot be found.

The above are material considerations. How about our environment and the cultural, psychological and social considerations in a "new America" with 75 or 100 million more people. Here indeed our thoughts must tread the tenuous tight-rope of ideas and preconceptions. What kind of a land, what kind of a life do we want? Every city will be almost twice its present size, countrysides will become suburbianas, the traffic trickles and streams of 1956 will become ever-flowing rivers in the "80s," the sky above us full of jets, the silent lake and mountain valley hidden beyond "the last horizon." Perhaps this is what we want—or do we? It's all in the point of view, and we have not given it our thought as yet.

* * *

There is no ready answer, nor is there any quick solution because our present attitude towards family size will compound these difficulties in the years immediately

ahead. The choice lies with each parent. The individual is the nation. The choice, however, cannot be made until we formulate a point of view we wish for our country. In our inner thoughts we may be thankful that the compulsions for our choice are not as desperate as those facing the great majority of people in other countries. We can even dare to hope that they never will be. This, however, will depend upon the decision we make which can serve our own interests as well as those of other people throughout the world. . . .

A Geochemist's View

Dr. Harrison Brown, Professor of Geochemistry at the California Institute of Technology and author of "The Challenge of Man's Future." The official abstract is reprinted in its entirety.

Today we are in the middle of a revolution. We are in the middle of a transition from one major level of culture to another—from a culture which is primarily agrarian to one which is primarily urban-industrial. The closest parallel in the past course of human existence was the transition, which took place some 7,000 years ago from a culture of food-gathers to a culture of farmers.

During the last 300 years man has achieved a degree of power over his environment which is unprecedented in the thousands of years of human history and in the hundreds of thousands of years of human pre-history. Our rate of material progress and our rate of growth seem to be steadily accelerating and one cannot help asking: For how long can this acceleration and this growth continue? Will we continue to accelerate? Will we level off? Could it be that, perhaps without realizing it, we are painting ourselves into a corner? Could it even be that we are headed towards catastrophe?

If we are able in the years ahead to avoid catastrophe it seems reasonably certain that demands for goods will increase rapidly to much higher levels than prevail today. Industrialization has spread thus far to only a small part of the world and it is destined to become world wide. Within industrial societies themselves demands for raw materials will increase as the result of increasing population and the need for an ever-more elaborate and complicated technology to cope with the increasing pressures upon the earth's resources.

Suppose that the underdeveloped areas of the world were suddenly to be brought up to a level of consumption which approaches that in the industrial world today. In order to accomplish this one would have to extract from the earth 18 billion tons of iron, 300 million tons of copper, an equal amount of lead, over 200 million tons of zinc and about 30 million tons of tin, in addition to huge quantities of other metals and non-metals. These

totals would be well over 100 times the present world annual rate of production.

The production of such huge quantities of materials would exhaust most of the earth's high-grade reservoirs of metals. But when we view the situation solely from the technological point of view it is clear that in principle even much larger quantities of materials than these can be extracted from the earth. From the technological point of view our industrial productive potential is limited only by the rate at which we can pour energy into the industrial network. And we know that in the sun's rays and in the uranium of rocks we have nearly an infinite quantity of energy available for tapping when we need it. It does not take much imagination to visualize a total world-wide industrial productivity 10, 100 or even 1000 times greater than that of today.

Similarly our food production potential is much higher than today's productivity. We know that a world-wide extension of the best conventional agricultural practices of today would suffice to feed adequately several times the present world population. By resorting to unconventional techniques such as the irrigation of vast areas of the world with reclaimed sea water it is conceivable that as many as 50 billion persons could be supported.

Unfortunately however although man can in principle provide adequately for a much larger population than exists today he is confronted by an enormous obstacle—that of the *rate* at which productivity can be increased. We know that industrial production can be increased rapidly. In the U.S., Japan and the U.S.S.R. major industrial production has been doubled every 5 to 10 years for very long periods of time. But even at this rapid rate of increase decades and generations are required for the average person to notice much improvement in his way of life.

It is in the area of food productivity however where we are confronted with the greatest difficulties. These difficulties stem from the fact that to change agricultural procedures we must change the attitudes and beliefs of a great many people. And attitudes and beliefs change slowly, over generations rather than over years. In spite of huge efforts in various areas of the world it has been found difficult to increase food productivity at a rate much faster than about 2 percent per year. When we couple this with the fact that populations can increase at rates which are as high as 3 percent per year and with the additional fact that the vast majority of the world's peoples are already hungry, the prospects are far from cheery.

Thus unless it is possible in some way to slow down birth rates or to speed up the rate of increase of food production far above the best that has thus far been achieved

we are faced with the prospect of watching industrialization spread to areas where people are hungry today and are destined to remain hungry for a long time in the future. Both of these steps involve processes of cultural change and as such they are more social and psychological problems and problems of communication than purely technological ones. Unless new techniques are developed in these areas it would appear that man's future is not destined to be a very comfortable one in spite of the huge productive potential which is at his disposal.

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